CLAIMS

We Claim:

1. A laser apparatus comprising:

an active periodic one dimensional dielectric structure configured to produce a photonic stop band having at least one long-lived photonic mode occurring therein; and

excitation means, applied to said active periodic structure, for causing said active periodic structure to emit electromagnetic radiation, wherein said excitation means is configured to produce peak gain approximately positioned at one of said at least one long-lived photonic modes such that lasing output occurs with at least one of: a maximum output power and a minimized lasing threshold.

2. The laser apparatus of claim 1, wherein said at least one long lived photonic mode is located at least at one of: a first band edge of said photonic stop band, and a second band edge of said photonic stop band.

3. The laser apparatus of claim 1 further comprising a defect disposed in said structure causing a defect state therein, wherein said at least one long-lived photonic mode is located at least at on of: a first band edge of said photonic stop band, a second band edge of said photonic stop band, and a defect state substantially central to said photonic stop band.

4. The laser apparatus of claim 3, wherein said defect comprises one of: a spatial displacement between portions of said structure, and an additional material positioned within said structure.

5. The laser apparatus of claim 1, wherein said dielectric structure is a cholesteric liquid crystal.

6. The laser apparatus of claim 1, wherein said active periodic structure comprises at least one of: a fluorescent dye, a conjugated polymer, and a rare earth element.

7. A laser apparatus comprising:

an active periodic one dimensional dielectric structure configured to produce a photonic stop band having a first band edge and a second band edge; and

excitation means, applied to said active periodic structure, for causing said active periodic structure to emit electromagnetic radiation, wherein said excitation means is configured to produce peak gain positioned at approximately one of said first band edge and said second band edge such that lasing output occurs with at least one of: a maximum output power and a minimized lasing threshold.

8. A laser apparatus comprising:

an active periodic one dimensional dielectric structure having a defect disposed therein and configured to produce a photonic stop band having a first band edge, a second band edge and a defect state corresponding to said defect; and

excitation means, applied to said active periodic structure, for causing said active periodic structure to emit electromagnetic radiation, wherein said excitation means is configured to produce peak gain positioned at approximately one of said first band edge, said second band edge, and said defect state such that lasing output occurs with at least one of: a maximum output power and a minimized lasing threshold.

9. A laser comprising:

an active periodic one dimensional dielectric structure of a first periodicity, comprising an active element and configured to produce a photonic stop band having a first band edge and a second band edge; and

an excitation source applied to said periodic structure operable to cause lasing at the wavelength of one of said stop band edges in a direction perpendicular to said periodic structure.

10. The laser of claim 9, further comprising:

a second periodic structure of a second periodicity adjacent to said active periodic structure for reflection of said lasing.

11. The laser of claim 10, further comprising:

a third periodic structure of a third periodicity, said third periodic structure being optimized for at least maximum output lasing power, positioned adjacent to said active periodic structure.

12. The laser of claim 9, further comprising:

a defect within said active periodic structure to distort said first periodicity to create at least one additional photonic defect state within said stop band, such that lasing is produced at a frequency corresponding to the defect state.

13. The laser of claim 9, wherein said active element comprises at least one of: a fluorescent dye, a conjugated polymer, and a rare earth element.

14. The laser of claim 9, wherein said active periodic structure is a cholesteric liquid crystal.

15. The laser of claim 14, wherein said cholesteric liquid crystal comprises a first pitch, a first ordinary index of refraction, and a first extraordinary index of refraction, further comprising:

a second periodic structure having at least one of: a second pitch, a second ordinary index of refraction, and a second extraordinary index of refraction, said second periodic structure being positioned adjacent to said active periodic structure for reflection of lasing output.

16. The laser of claim 15, further comprising:

a third periodic structure having at least one of: a third pitch, a third ordinary index of refraction, and a third extraordinary index of refraction, said third periodic structure being positioned adjacent to said active periodic structure and opposite from said second periodic structure, said third periodic structure being optimized for at least one of: a maximum output power and a minimized lasing threshold.

17. The laser of claim 9, wherein said active periodic structure is a layered dielectric structure.

18. The laser of claim 17, wherein said layered dielectric structure comprises alternating layers of a dielectric materials having correspondingly alternating indices of refraction.

19. The laser of claim 18, wherein said layered dielectric structure comprises a first period, a first ordinary index of refraction, and a first extraordinary index of refraction, further comprising:

a second periodic structure having at least one of: a second period, a second ordinary index of refraction, and a second extraordinary index of refraction, said second periodic structure being positioned adjacent to said active periodic structure for reflection of lasing output.

20. The laser of claim 19, further comprising:

a third periodic structure having at least one of: a third period, a third ordinary index of refraction, and a third extraordinary index of refraction, said third periodic structure being positioned adjacent to said active periodic structure and opposite from said second periodic structure, said third periodic structure being optimized for at least one of: a maximum output power and a minimized lasing threshold.

21. A laser comprising:

an active cholesteric liquid crystal structure configured to produce a photonic stop band having a first band edge and a second band edge, and comprising an active material responsive to optical pumping; and

an optical pump applied to said cholesteric liquid crystal structure for causing lasing at one of said band edges.

22. A laser comprising:

an active cholesteric liquid crystal structure configured to produce a photonic stop band having a first band edge and a second band edge, and comprising an active material responsive to voltage applied thereto; and

a voltage source applied to said cholesteric liquid crystal structure for causing lasing at one of said band edges.

23. A laser comprising:

a planar active cholesteric liquid crystal structure configured to produce a photonic stop band having a first band edge and a second band edge, and comprising an active material; and

an excitation source applied to said active cholesteric liquid crystal structure in its plane for causing lasing at one of said band edges, said lasing being emitted in a plane of said cholesteric liquid crystal structure.

24. A method of lasing, comprising the steps of:

(a) providing an active periodic one dimensional dielectric structure configured to produce a photonic stop band having a plurality of long-lived photonic modes occurring therein;

(b) configuring an excitation source to produce peak gain approximately positioned at one of said plural long-lived photonic modes; and

(c) applying excitation to said active periodic structure via said excitation source to cause said active periodic structure to emit electromagnetic radiation with at least one of: a maximum output power and a minimized lasing threshold.

25. The method of lasing of claim 24, wherein said plural long lived photonic modes are located at least at one of: a first band edge of said photonic stop band and a second band edge of said photonic stop band.

26. The method of lasing of claim 24, further comprising the step of:

(d) prior to said step (b), generating an additional long lived photonic mode in said periodic structure by causing a defect in said structure.

27. The method of lasing of claim 26, wherein said defect comprises one of: a spatial displacement between portions of said structure and an additional material positioned within said structure.

28. The method of lasing of claim 24, wherein said dielectric structure is a cholesteric liquid crystal.

29. The method of lasing of claim 26, wherein said active periodic structure comprises at least one of: a fluorescent dye, a conjugated polymer, and a rare earth element.

30. A method of lasing comprising the steps of:

(a) providing an active periodic one dimensional dielectric structure configured to produce a photonic stop band having a first band edge and a second band edge;

(b) configuring an excitation source to produce peak gain positioned at approximately one of said first band edge and said second band edge; and

(c) applying excitation to said active periodic structure via said excitation source to cause said active periodic structure to emit electromagnetic radiation with at least one of: a maximum output power and a minimized lasing threshold.

31. A method of lasing, comprising the steps of:

(a) providing an active periodic one dimensional dielectric structure having a defect disposed therein and configured to produce a photonic stop band having a first band edge, a second band edge and a defect state corresponding to said defect;

(b) configuring an excitation source to produce peak gain positioned at approximately one of said first band edge, said second band edge, and said defect state; and

(c) applying excitation to said active periodic structure via said excitation source to cause said active periodic structure to emit electromagnetic radiation with at least one of: a maximum output power and a minimized lasing threshold.

32. A method of lasing, comprising the steps of:

(a) providing an active periodic one dimensional dielectric structure of a first periodicity, comprising an active element and configured to produce a photonic stop band having a first band edge and a second band edge; and

(b) applying excitation to said periodic structure to cause lasing at the wavelength of one of said stop band edges in a direction perpendicular to said periodic structure.

33. The method of claim 32, further comprising the step of:

(c) providing and positioning a second periodic structure of a second periodicity adjacent to said active periodic structure for reflection of said lasing.

34. The method of claim 33, further comprising the step of:

(d) providing and positioning, adjacent to said active periodic structure, a third periodic structure of a third periodicity, said third periodic structure being optimized for at least one of: a maximum output lasing power and a minimized lasing threshold.

35. A method of lasing, comprising the steps of:

(e) providing an active periodic one dimensional dielectric structure of a first periodicity and configured to produce a photonic stop band;

(f) providing a defect within said active periodic structure to distort said first periodicity to create at least one photonic defect state within said stop band; and

(g) applying excitation to said periodic structure to cause lasing at the wavelength of said defect state in a direction perpendicular to said periodic structure.

36. The method of claim 32, wherein said active element comprises at least one of: a fluorescent dye, a conjugated polymer, and a rare earth element.

37. The method of claim 32, wherein said active periodic structure is a cholesteric liquid crystal.

38. The method of claim 37, wherein said cholesteric liquid crystal comprises a first pitch, a first upper index of refraction, and a first extraordinary index of refraction, further comprising the step of:

(h) providing, and positioning adjacent to said active periodic structure, a second periodic structure having at least one of: a second pitch, a second upper index of refraction, and a second extraordinary index of refraction, to cause reflection of lasing output.

39. The method of claim 38, further comprising the step of:

(i) providing, and positioning adjacent to said active periodic structure and opposite from said second periodic structure, a third periodic structure having at least one of: a third pitch, a third upper index of refraction, and a third extraordinary index of refraction, said third periodic structure being optimized for at least one of: a maximum output lasing power and a minimized lasing threshold.

40. The method of claim 32, wherein said active periodic structure is a layered dielectric structure.

41. The method of claim 40, wherein said layered dielectric structure comprises alternating layers of a dielectric materials having correspondingly alternating upper and lower indices of refraction.

42. The method of claim 41, wherein said layered dielectric structure comprises a first period, a first upper index of refraction, and a first lower index of refraction, further comprising the step of:

(j) providing, and positioning adjacent to said active periodic structure, a second periodic structure having at least one of: a second period, a second upper index of refraction, and a second lower index of refraction, to cause reflection of lasing output.

43. The method of claim 42, further comprising the step of:

(k) providing, and positioning adjacent to said active periodic structure and opposite from said second periodic structure, a third periodic structure having at least one of: a third period, a third upper index of refraction, and a third lower index of refraction, said third periodic structure being optimized for at least one of: a maximum output lasing power and a minimized lasing threshold.

44. A method of lasing comprising the steps of:

(a) providing an active cholesteric liquid crystal structure configured to produce a photonic stop band having a first band edge and a second band edge, and comprising an active material responsive to optical pumping; and

(b) applying an optical pump to said cholesteric liquid crystal structure to cause lasing at one of said band edges.

45. A laser comprising:

(a) providing an active cholesteric liquid crystal structure configured to produce a photonic stop band having a first band edge and a second band edge, and comprising an active material responsive to voltage applied thereto; and

(b) applying a voltage source to said cholesteric liquid crystal structure to cause lasing at one of said band edges.

46. A method of lasing comprising the steps of:

(a) providing a planar cholesteric liquid crystal structure configured to produce a photonic stop band having a first band edge and a second band edge, and comprising an active material; and

(b) applying an excitation source to said cholesteric liquid crystal structure in its plane to cause lasing at one of said band edges, said lasing being emitted in a plane of said cholesteric liquid crystal structure.